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Scanning probe microscopy application in a research of opal nanostructures

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The paper presents the results of a study of the formation of multilayer structures based on opal films on a scanning probe microscope Solver P-47 using atomic force and tunneling microscopy and current spectroscopy. It has been revealed that tunneling microscopy methods are suitable for studying chromium-opal-gold-carbon layered structures.

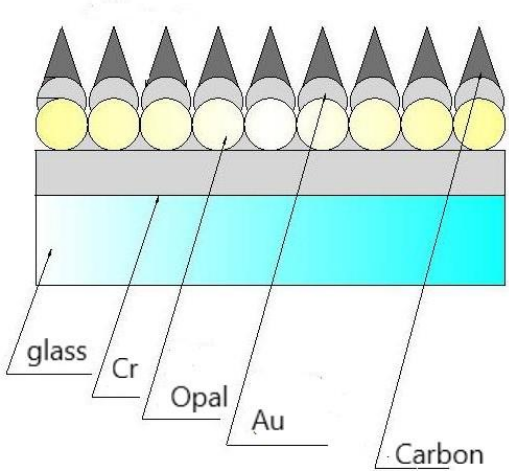

Figure 1. Chrome - opal - gold - carbon structure.

Surface images and current-voltage characteristics obtained as the structures are formed along the layers are shown. It is shown that the formation of film structures on the surface of opal matrices begins with the formation of "islands" on tops of silica spheres. It was found that the deposition of carbon films on the surface of the chrome-opal-gold structure leads to an increase in tunnel currents in the tip-sample gap. The presented results can be used in the development of technology for the formation of a variety of layered structures on the surface of opal matrices, in particular, in the production of photonics, various sensor systems and emission devices.

A comparison of the profiles of the surfaces of opal films and the gold layer formed on it once again confirmed the mechanism of growth of metal films detected earlier on [1,2] and the above mentioned mechanism on the surface of the opal matrix. The study of images and profiles of the surface deposited on the gold layer of carbon showed that carbon structures were formed mainly on the areas located above the vertices of the silica spheres on the "islets" of gold, which led to an increase in the relief height of these sections. The carbon layer has a "pimply" surface, this is noticeable both in the surface image, and in the relief profiles. At the same time, the relief of the peaks became more developed. Moreover, the deposition of carbon not from the gas phase, but by the magnetron method, performed for comparison on some samples, led to the formation of a surface with a similar relief character.

1. E.V. Panfilova et al., *Nanoengineering* **1**, 12 (2016).
2. E.V. Panfilova, A.B. Syritskii, E.V. Vagulina, *Nanoengineering* **1**, 1 (2015).